

Organic farming enhances the recovery of ancient crops and segetal weeds in Catalonia (NE of Spain)

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Abstract

The Area of Natural Interest of Gallecs is nowadays one of the largest areas of arable land organically managed in Catalonia. In 2005 a project was launched to convert fields to organic farming and recuperate traditional crop varieties. The aim of this work is to analyse the changes in weed diversity, including both segetal and rare species, and of crops in 20 fields (ca. 46 ha) after the conversion to organic farming during 5 cropping periods (2005-2010). The number of cultivated crops increased from 1 to 17, including ancient and local varieties of cereal and legumes. Weed biodiversity at regional scale doubled in 5 years, whereas the presence of segetal and rare species increased by 75 % and 136 % respectively. Thus, organic farming contributes to the increase and the conservation of weed diversity in arable agroecosystems, including segetal species which are currently rare or have even disappeared from most of the conventional arable fields.

Introduction

In European arable crops, weed species richness and abundance have diminished due to agricultural intensification at both regional and field levels (Andreasen et al. 1996, Hyvönen et al. 2003, Baessler and Klotz 2006). It is well known that organically managed fields harbour higher weed diversity than the conventional ones (Hole et al. 2005, Roschevitz et al. 2005, Armengot et al. 2012), including segetal flora (van Elsen 2000, Romero et al. 2008, José-María et al. 2010).

The Area of Natural Interest of Gallecs is nowadays the largest arable area organically managed in Catalonia (202 ha). In 2005 its managing body and the farmers of the Agroecological Association of Gallecs, with the collaboration of the Agroecosystems Research Group¹, launched the conversion to organic farming and the recuperation of traditional crop varieties.

The aim of this work is to analyse the changes in diversity of the weed flora and of crops in 20 fields (45.8 ha) after the conversion to organic farming during 5 cropping periods.

Material and methods

Study site

The study was carried out in the "Espai d'Interès Natural de Gallecs" (Area of Natural Interest of Gallecs) of the Catalan Government, in the municipality of Mollet del Vallès, located 15 km north of Barcelona, Spain (2° 12' 7.6" E, 41° 33' 42.8" N). Field samplings were conducted over five seasons (from 2005 to 2010) in cereal and legume crops organically managed in rotations of 3 and 4 years (1 year legume and 2 or 3 years of cereal crop, respectively). The area of 747 ha is dominated by arable land (ca 71 %) and forest stands. Arable fields are both managed conventionally (343 ha) and organically (202 ha). The climate is dry subhumid Mediterranean, with mean annual temperatures and rainfall of 14.5 °C and 602 mm respectively, and the soil is calcareous.

Sampling

The abundance of the weed flora was evaluated yearly before crop harvest (between the end of June and beginning of July). Along one of the diagonals of each field we visually estimated the percentage of cover of every weed in 15 evenly distributed samples (1 m × 1 m). The richness, the abundance and the frequency of the weed species in each field and year were analysed, focusing on the segetal and rare species in Catalonia following de Bolòs et al. (1984, 2005). In order to detect the presence of new weed species in the area, local farmers were interviewed and the Flora Database of Catalonia (from the Catalan Biodiversity Data Base –BDBC– 2011) was consulted. Analyses were performed with the SPSS statistics package (SPSS 2009).

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Results and Discussion

The conversion to organic farming increased the number of crops, from a monoculture of barley before 2005, to a total of 17 different varieties (mean of 8 crops per year), including ancient and local varieties of cereals, such as spelt (*Triticum aestivum* subsp. *spelta* L.), khorasan wheat (*Triticum turanicum* Jakubz.), some local varieties of wheat (*Triticum aestivum* L. var. *Montcada* and *T. aestivum* var. *Alcalá*), white and black oats (*Avena sativa* L.), barley (*Hordeum vulgare* L.), rye (*Secale cereale* M.Bieb.), raygrass (*Lolium multiflorum* Lam.) and triticale (\times *Triticosecale* Wittm. ex A. Camus.); and some legumes such as bitter vetch (*Vicia ervilia* (L.) Willd.), fenugreek (*Trigonella foenum-graecum* L.), brown Spanish Pardina lentils (*Lens culinaris* Medik. var. *variabilis*), pea (*Pisum sativum* L.), chickpea (*Cicer arietinum* L.), broad bean (*Vicia faba* L.) and lucerne (*Medicago sativa* L.).

The total weed species richness of the 20 sampled fields doubled in five years, from a total of 61 species in 2005 up to 122 species in 2010 (mean annual richness of 66 species). The weed species richness per field increased from 17.9 to 22.4 species in five years (mean species richness per field and year of 16.9). The mean of the accumulative specific cover per field and year was 19 %. The most abundant species in cereal crops were *Convolvulus arvensis* L. (mean cover per sample of 3.6 %), *Papaver rhoeas* L. and *Polygonum aviculare* L., while the most frequent was *P. aviculare*, which was present in 59.3 % of the samples of each field. The most abundant species in legume crops were *Diploaxis erucoides* L. (DC.) (mean cover of 5.7 %), *Cynodon dactylon* (L.) Pers. and *Polygonum convolvulus* L. and the most frequent was *D. erucoides*, which was present in 53.1 % of the samples of each field.

The presence of rare and segetal species at regional scale increased up to 136 % and 75 % respectively from 2006 to 2010. Some of this species such as *Agrostemma githago* L., *Ammi majus* L., *Ammi visnaga* (L.) Lam, *Bromus secalinus* L., *Chrozophora tinctoria* (L.) A. Juss., *Stachys annua* L. and *Vaccaria hispanica* (Mill.) Rauschert had not been observed before in this area. It was remarkable the presence of up to 21 segetal and 26 rare species, that accounts for 17 % and 21 % respectively of the total weed flora. Some segetal and rare species such as *Ammi visnaga*, *Bromus secalinus*, *Euphorbia prostrata* Aiton, *Papaver hybridum* L., *Vicia bithynica* (L.) L. colonised few fields or appeared only one year. However, others, such as *Agrostemma githago*, *Ammi majus*, *Stachys annua* and *Vaccaria hispanica* increased their frequency in the study area from 2 up to 8 fields in five years.

Thus, crop rotations, lack of application of herbicides and sowing own organic seeds or from other farmers can contribute to the increase and the conservation of the weed diversity in the arable agroecosystems at field and regional scale. This enhancement of weed diversity is particularly relevant for segetal species, which have currently become very rare or have even disappeared from most of the conventional arable fields (Storkey et al. 2012).

Our results support that organic farming in arable areas constitutes an environmentally friendly scheme to face the loss of biodiversity recorded in the last decades (Chamorro et al. 2007).

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